PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN THE APPLICATION OF: CONFIRMATION NO.: 3257

AKHILESWAR GANESH VAIDYANATHAN ET. AL. CASE NO.: CL1666USNA

APPLICATION NO.: 09/851674 GROUP ART UNIT: 1631

FILED: MAY 09, 2001 EXAMINER: LIN, JERRY

FOR: METHOD OF DISCOVERING PATTERNS IN SYMBOL SEQUENCES

APPEAL BRIEF UNDER 37 CFR 41.37

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In accordance with the practice under 37 CFR 41.37 the following is an Appeal Brief in support of the appeal filed March 19, 2007, appealing the Rejection dated December 20, 2006 of Claims 35-53 and 66-68, all of the pending claims of this application.

A Petition for Extension of Time extending the period for submission of this Appeal Brief until Sunday, August 19, 2007, is enclosed with this paper.

Please charge any necessary Appeal Brief fee pursuant to 37 CFR 41.20(b)(2), to Deposit Account No. 04-1928 (E. I. du Pont de Nemours and Company). The Commissioner is hereby authorized to charge any additional fees which may be required or credit any overpayment to Deposit Account No. 04-1928.

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REAL PARTY IN INTEREST

The real party in interest is E. I. du Pont de Nemours and Company (the "Assignee"), 1007 Market Street, Wilmington, Delaware 19898, to whom this application has been assigned, said assignment being recorded at Reel 012223, Frame 0540.

RELATED APPEALS AND INTERFERENCES

There are no other known appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

STATUS OF CLAIMS

Claims 1-34 Cancelled

Claims 35-53 Rejected

Claims 54-65 Cancelled

Claims 66-68 Rejected

Claims 35-53 and 66-68 are set forth in the Claims Appendix.

STATUS OF AMENDMENTS

Following filing of a first Appeal Brief on September 28, 2006, prosecution was re-opened and the claims were rejected by an Office Action dated December 20, 2006.

The Rejection of December 20, 2006 was appealed on March 19, 2007.

No amendments have been submitted following the latest rejection.

SUMMARY OF CLAIMED SUBJECT MATTER

In its method aspect recited in independent claims 35, 42 and 44 the present invention is directed to the identification of existing patterns in a set of "k" number of sequences. The k number of sequences is termed a "k-tuple". The k number of sequences form part of an overall set of "w" number of sequences. Each of the w sequences has a given length, but the sequences need not be the same length. A "pattern" is a distributed substring of elements that occurs in at least two sequences in the set of sequences (Page 7, lines 36-38). Two representative sequences S_1 and S_2 are shown at page 7, lines 30-31 and 33-34. As is apparent by inspection each sequence S_1 and S_2 is a series of alphabetic symbols.

The basic steps that comprise the core of the method of the present invention may be understood from the following discussion of the "two-tuple" (k = 2) of the sequences S_1 and S_2.

Each member element of a sequence is represented by an alphabetic symbol. Each symbol occupies a given location in a sequence. This location is termed the symbol's "position index". The pairing of a symbol and its position index identifies a unique symbol at a unique location in a sequence.

The first step of the method is to create for each sequence a table of ordered pairs pairing a symbol with a position index, thus (symbol, position index). For instance, in the sequence S_1 the symbol "L" occurs at position indices 18 and 46, producing respective ordered pairs (L, 18) and (L, 46). The symbol "K" occurs at position indices 20, 25, 34 and 35, producing respective ordered pairs (K, 20), (K, 25), (K, 34) and (K, 35). In the sequence S_2 the symbol "L" occurs at position indices 6, 23 and 30 and the symbol "K" occurs at position indices 8, 10, 14 and 32, generating similar ordered pairs.

The association of each symbol and its position index is used to form a "master offset table" for each sequence. Figure 1 shows two master offset tables for the "two-tuple" of sequences S_1 and S_2. Each master offset table groups, for each symbol, the position in the sequence occupied by each occurrence of that symbol.

Thus, in the master offset table for the sequence S_1 the position indices "18" and "46" are listed under the symbol "L" while position indices "20", "25", "34" and "35" are listed under the symbol "K". Similarly, for the sequence S_2

position indices "6", "23" and "30" are listed for the symbol "L" and position indices "8", "10", "14" and "32" are listed for the symbol "K".

Next, the difference-in-position between each occurrence of a symbol in one of the sequences and each occurrence of that same symbol in the other sequence is determined. This determination is facilitated by concatenating the two sequences (page 10, line 15). A table, termed a "pattern map" (page 9, lines 32-33) or a "tuple-table" (page 30, line 25 through page 31, line 15) is formed in which each row in the table represents a single value of "difference in position" (page 9, lines 20 through page 10, line 6).

Figures 2A and 2B depict the pattern map for the two-tuple of sequences S_1 and S_2. Since sequence S_1 contains 47 characters and the sequence S_2 contains 54 characters the pattern map is 101 rows in depth (numbered "0" to "100"). For each given value of a difference-in-position (the value being termed the "row index") the table lists the position of each symbol in the first sequence that appears again at a spacing corresponding to that difference-in-position value.

Consider the symbol "R" listed in the master offset table for the sequence S_1 (at position index "44") and the position indices for the same symbol "R" as listed in the master offset table for the sequence S_2 (position indices "7", "21", "31"). From the master offset tables and the concatenation of the sequences S_1 and S_2 at page 7 it may be determined that:

- from the occurrence of the symbol "R" in the first sequence,

--the first occurrence of the symbol "R" in the second sequence is spaced ten places;

--the second occurrence of the symbol "R" in the second sequence is spaced twenty-four places; and

--the third occurrence of the symbol "R" in the second sequence is spaced thirty-four places.

The pattern map of Figures 2A and 2B thus lists the position index "44" (corresponding to the symbol "R") on row indices (difference-in-position values) "10", "24" and "34".

The symbols collected for any row index set forth (that is, "define") a parent pattern in the first sequence that is repeated in the second sequence. The pattern may be then be read-out (page 12, lines 5 through 10).

Consider the discussion at page 11, line 24 through page 12, line 30 for the row index value "35" in the pattern map of Figure 2A. This row index value identifies the pattern corresponding to the symbols at position indices "18", "20", "21", "30", "39" and "40". The value "6" in the symbol count column to the immediate right of the colon on Figure 2A (page 10, line 37 through page 11, line 2) indicates that there are six symbols in the pattern.

By consulting sequence S_1 the position indices "18", "20", "21", "30", "39" and "40" respectively correspond to the symbols "L", "K", "V", "V", "P", "H".

The collected symbols corresponding to a difference-in-position value "35" thus set forth the pattern:

"L . KV . . . . . V . . . . . PH"

occurring in the first sequence S_1 that also appears in the second sequence S_2 (page 12, line 16). The dots in the pattern indicate placeholders (page 12, lines 19-21).

Claim 66 is directed to a computer-readable medium containing data structures useful in controlling a computer system to discover patterns in k sequences of symbols. The data structures correspond to the steps of method claim 35.

Claim 68 is directed to a computer-readable medium containing instructions for controlling a computer system to discover one or more patterns in two sequences of symbols S_1 and S_2 by performing the steps of method claim 35.

Both claims 66 and 68 contain language using difference-in-position values as the selection criteria for identifying repeating patterns of symbols.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 35-53 and 66-68 are rejected under 35 U.S.C. § 101 as being directed to non-statutory subject matter.

Claims 66 and 67 are rejected under 35 U.S.C. § 103(a) as being unpatentable as evidenced by United States Patent 5,577,249 (Califano).

ARGUMENT

I. Rejection Under 35 U.S.C. § 101

A. Claims 35-53 and 66-68 In paragraphs 3 through 7 of the Action claims 35-53 and 66-68 stand rejected as being presented to non-statutory subject matter.

For the reasons set forth herein this rejection is erroneous and should be reversed.

1. The Invention Is Not A Mathematical Algorithm

In paragraph number 3 of the Action the claims have been rejected because, in the view of the Examiner:

> "The instant claims are drawn to [a] mathematical algorithm for identifying patterns in a sequence of symbols."

A mathematical algorithm has been defined as a procedure for solving a given type of mathematical problem. Gottschalk v. Benson, 409 U.S. 63, 75, 175 USPQ 673, 674 (1972).

The present invention is directed to a method of identifying one or more patterns in sequences (or series) of symbols within an overall set of sequences. This is not a mathematical problem. It is the positional relationship among the various symbols in the sequences, not any mathematical meaning of a symbol, that is important to the method of the present invention. See, In re Freeman, 573 F.2d 1237, 197 USPQ 464 (CCPA 1978).

Thus, the present invention as recited in claims 35-53, 66-68 can not be characterized as a "mathematical algorithm".

2. The Invention Is Not An Abstract Idea

In paragraph 7 the Examiner characterizes the present invention as "an abstract idea". This characterization is also incorrect.

The invention is directed a series of steps that treats symbols as "things", in particular, to a precise series of steps to be carried out to

identify positional patterns of alphabetic symbols present in a set of two or more symbol sequences.

As pointed out in the earlier Brief (Appeal Brief, September 28, 2006, page 11), in the context of the present invention, both a "symbol" and a "sequence" of symbols are treated as "things".

On one level a symbol is a "thing" because the symbol physically exists. It exists either as a collection of ink molecules or as a collection of electrons. In either case the symbol is a physical entity. Moreover, a "sequence" of symbols is also a "thing" because a sequence cannot exist in isolation - a "sequence" must contain a series or collection of things.

On another level, even if one refuses to accept the physical reality of a symbol, the symbol may be viewed as a representation of other "things", whether those other things be chemicals, dollars, or other physical objects. In this sense also the present invention operates to find patterns among "things".

It should be noted when viewing a symbol on this level of understanding, even if the symbol were taken to represent a mathematical quantity, the invention is nevertheless statutory. Again, it must be emphasized, that the method of the present invention is not concerned with the mathematical meaning of the symbol. Instead, it is the positional relationship among the symbols within the sequences that is important.

The present invention as recited in claims 35-53, 66-68 is not directed to an abstract idea.

3. The Invention Is Useful, Tangible and Concrete

As an alternative ground of decision, even if a mathematical algorithm is deemed to be present, it is clearly the law that the practical use of that algorithm to produce a useful, tangible and concrete result is patentable subject matter. State Street Bank & Trust Co. v. Signature Financial Group, Inc., 47 USPQ2d 1596 (Fed. Cir. 1998).

In paragraph number 4 of the rejection the Examiner disputes whether the present invention is "useful" and "tangible".

a. Useful According to the Examiner, since the instant claims do not produce a result that is "substantial", the invention is not "useful".

The examiner relies upon MPEP 2107.01(I)(B) to define "substantial utility" as a "real-world" use.

However, the Examiner appears to have overlooked the admonition at the conclusion of that same section of the Manual to the effect that:

> "... any reasonable use that an applicant has identified for the invention that can be viewed as providing a public benefit should be accepted as sufficient, at least with regard to defining a 'substantial' utility." (emphasis added).

The present application identifies the use of the present invention in the discovery of patterns in generalized alphabetic sequences (page 20, line 10 to page 22, line 16 and Figure 3), in alphabetic sequences representing physico-chemical properties (page 5, line 29 to page 6, line 24), and in alphabetic sequences used in the description of biological properties (page 5, line 17 - 28).

In addition, several patent publications and scientific articles discuss the usefulness of pattern discovery in a variety of contexts.

For example, U.S Patent 5,577,249 (Califano) relates to a pattern discovery technique having applications "in the biological sciences (human genome mapping or analyzing proteins) and in image, speech and music recognition" (Abstract). The Califano patent is cited in the Information Disclosure Statement filed December 2, 2002 and is currently relied upon by the Examiner as the basis for a rejection under Section 103.

EP 0 898 236 A2, cited in the Information Disclosure Statement filed December 2, 2002, mentions the use of pattern

discovery in at least two additional disparate fields of endeavor:

-language analysis, particularly of ancient languages, e.g., Doron Witztum, et al, "Equidistant Letter Sequences in the Book of Genesis", Statistical Science, 1994, vol. 9, no. 3, pp. 429-438, (page 4, paragraph [0008]); and

-color and sound analysis (page 4, paragraph [0009]).

It is manifest that the use of pattern discovery in any of these various fields provides a public benefit. Accordingly, the present invention is clearly "useful".

As an aside, in an attempt to buttress his argument as to lack of utility, the Examiner (in the portion of paragraph 4 on page 4 of the Action) goes on to discuss his understanding that the present invention may be used:

> "to determine the number of times the letter 'a' appears in a newspaper. It is unclear how discovering this pattern provides a substantial utility."

Such an argument is a mischaracterization of the present invention and appears to illustrate only that the Examiner still fails to appreciate the nature of the present invention. The Examiner's statement is incorrect in at least three aspects.

First, the Examiner is incorrect in this use of the term "pattern". The mere frequency of a particular symbol (e.g., the letter "a") in a tract of text would not be a "pattern" as that term is used herein. The term "pattern" relates to the positional relationship among symbols in two or more sequences.

Second, the present invention is not about finding the frequency of occurrence of a particular symbol.

Third, even assuming that the present invention is directed to finding a symbol's frequency of occurrence, the substance of the examiner's statement is incorrect. For example, determining the

frequency of use of a symbol in a body of text has been discussed in the popular media as a useful first step in decryption analysis. See, e.g., NOVA scienceNOW: Kryptos (Episode 10), aired on PBS July 24, 2007.

b. Tangible The Examiner next disputes that the invention provides a tangible result. Although the precise reasoning of the Examiner (set forth in the text bridging pages 4 and 5 of the Action) is cloudy, it appears to involve one or more of the following contentions:

- 1) that a "real-world result" must be produced;
- 2) that a "final pattern" must "necessarily" be found; and/or
- 3) that the claims must "communicate" the result to a user.

As to the first contention, MPEP 2106 (IV)(C)2.(2)b) [page 2100-12, Rev. 5, Aug. 2006] make it clear that the criteria for a "tangible result" is met if a claim provides "a practical method or means of producing a beneficial result or effect" (quoting Corning v. Burden, 56 U.S. (15 How.) 252, 268 (1854). The preceding section of this brief makes it clear that the invention satisfies this contention.

The second contention of the Examiner, understood to mean that in some instances no pattern is found (assuming this is what is meant by the Examiner's term "final pattern"), is true only insofar as it applies to a trivial case. In a situation where no patterns are common to the sequences, then no pattern will be found. The present method will not find something that is not there. However, if a pattern is present in the sequences, the present invention is deterministic in the sense that these patterns will be found. However, knowledge gained from either alternative provides a "beneficial result". In the former instance information confirming that no patterns are common to the sequences is important. In the latter instance, finding common patterns is also a beneficial end.

As to the third contention - if a pattern present - the final step of the claimed method requires that the discovered pattern be "defined". Webster's New Collegiate Dictionary, Merriam-Webster Inc., Springfield, Massachusetts 1974, at page 297 (a copy of which is appended to this paper for the convenience of the Board) contains a definition for the word "define" to that includes:

> "2 ... b: to discover and set forth ..." (emphasis added).

The term "define" as used in the final step of the method of the present invention thus encompasses the concept of communication of the discovered pattern to a user. Presenting any discovered pattern to a user in a form where "reading out patterns is now simple" (specification page 12, line 6) is every bit at communicative to a user as the storage of calculated gains or losses is in State Street.

Clearly, the present invention includes a tangible result.

c. Concrete Although not addressed by the Examiner, the claimed invention is also "concrete".

MPEP 2106 (IV)(C)2.(2)c) [page 2100-12, Rev. 5, Aug. 2006] states as the criteria for a "concrete result" that:

> "[T]he process must have a result that can be substantially repeatable or the process must substantially produce the same result again."

As alluded to above, the present method is deterministic. If the same sequences are presented to the instant method multiple times, the same patterns will be discovered regardless of the order in which the sequences are presented. Therefore, the method of the present invention produces "substantially repeatable" results and meets the criteria as "concrete".

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In sum, the identification of patterns of symbols occurring within plural sequences in accordance with the present invention is sufficiently "useful, tangible and concrete" to qualify as statutory subject matter under 35 U.S.C. § 101.

4. Pattern Discovery Is Recognized As Eligible Subject Matter

The following issued United States Patents, directly or indirectly present in the record, recognize that claims including operations on sequences of symbols (or equivalent terms) which involve no more communicative action than is present here qualify as statutory subject matter:

1) U.S. Patent 5,577,249 (Califano), cited in the Information Disclosure Statement filed December 2, 2002 and currently relied upon by the Examiner;

2) U.S. Patent 6,092,065 (Floratos et al.), cited in the Information Disclosure Statement filed March 5, 2002;

3) U.S. Patent 6,108,666 (Floratos et al.) cited in the Information Disclosure Statement filed March 5, 2002;

4) U.S. Patent 6,571,199, a United States equivalent of WO 00/26818, cited in the Information Disclosure Statement filed March 5, 2002; and

5) U.S. Patent 6,785,672, also a United States equivalent of WO 00/26818, cited in the Information Disclosure Statement filed March 5, 2002.

(The materials listed on the Forms SB/08A and SB/08B submitted with the Information Disclosure Statements of March 5, 2002 and December 2, 2002 were considered on July 30, 2004. Copies of the Forms themselves were appended to the Office Action of August 10, 2004.)

These United States Patents, each issued by the PTO over a ten-year period after examination by a different examiner, buttress the

conclusion urged herein - that the pattern discovery method of the present invention is statutory subject matter.

5. Claim 68 Is Statutory

Paragraph 6 of the Action is specifically directed to claim 68.

Claim 68 recites "A computer-readable medium containing instructions for controlling a computer system" to perform the functional steps exactly as recited in method claim 35.

The Examiner repeats his position that:

> "[T]he method of claim 35 does not require a useful or tangible result and is not a practical application of a judicial exception. Thus instant claim 68 also does not include a practical application of a judicial exception."

As discussed above, the method of claim 35 does provide a useful, tangible and concrete result and is therefore statutory. For the same reasons claim 68 is also statutory.

B. Claims 66 and 67 Claims 66-67 are drawn to data structures embodied in a computer-readable medium. These claims have been rejected as non-statutory (paragraph 5 of the Action) because, in the view of the Examiner:

> "... [T]he instant claims do not provide the interrelationships between data structure and computer ... ."

This is clearly incorrect. Even the most cursory comparison between the data structure claims and the method claims shows that claims 66 and 67 do, in fact, provide the necessary structural and functional interrelationships between the data structure, the computer software (as expressed by the method steps recited in claim 35) and the computer hardware.

Specifically, with regard to claim 66, the "number w of master offset table data structures" recited therein correspond directly to the functional language set forth in method claim 35, steps a) and b). The "k-tuple table data structure" contains functional language related to method claim 35, step c). The "sorted k-tuple table data structure" relates directly to method claim 35, step d). Moreover, the final "wherein" clause directly correlates to method claim 35, step e).

Claim 67 further particularizes the "master offset table data structures" recited in claim 35 in the manner described in the specification at page 8, lines 27–37.

Thus the data structures of claims 66 and 67 are not "non-functional descriptive" material, but instead set forth the requisite interrelationships between the data structure and the software.

Claims 66 and 67 are statutory.

II. Rejection Under 35 U.S.C. § 103

Claims 66-67 have been rejected as unpatentable under 35 U.S.C. § 103(a) as evidenced by U.S. Patent 5,577,249 (Califano).

In paragraph number 10 the examiner has stated:

> "That data structure and its intended use, as in instant Claims 66 and 67, is considered to be "non-functional descriptive" material, for the reasons stated above.
>
> All limitations of this type of data structure are given no patentable weight, as they are non-functional descriptive material. The patentable weight given to the limitations of claims 66 and 67 are limited to any type of computer-readable medium storing any type of data structure."

As discussed above, claim 66 recites data structures that correspond to the steps of method claim 35. Each data structure recited in claim 66 thus represents the results of one or more functional steps of method claim 35. As such, these data structures are not "non-functional descriptive" material. They should clearly be accorded patentable weight.

When so considered the present data structures are clearly distinguished from the data structures of Califano. Any data structures in Califano do not include and do not utilize difference-in-position values to define patterns of symbols.

Since a data structure in accordance with the present invention includes this relationship between difference-in-position values and patterns, the present invention is not rendered obvious by the Califano reference.

III. Conclusion

For the reasons set forth it is submitted that the Examiner's rejections are improper and should be reversed, which action is earnestly solicited.

Respectfully submitted,

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CLAIMS APPENDIX

Claims 1-34 Cancelled

35. (Previously presented) A method of discovering one or more patterns in a set of k sequences of symbols, called a k-tuple, where k is greater than or equal to two, within an overall set of w sequences having sequence numbers 1, 2, ..., w , the symbols being members of an alphabet, each sequence of symbols having respective lengths L_1, L_2, ..., L_w, comprising the steps of:

a) translating the sequences of symbols into a table of ordered (symbol, position index) pairs, where the position index refers to the location of the symbol in a sequence;

b) for each of the w sequences, grouping the (symbol, position index) pairs by symbol to form a respective master offset table, thus creating w master offset tables;

c) using the position indices in the w master offset tables to determine the difference-in-position value between each occurrence of a symbol in one of the sequences and each occurrence of that same symbol in the other sequence in each master offset table , forming a k-tuple table associated with the k-tuple, the table comprising k columns, one of the k columns being a primary column and the remaining (k-1) columns being suffix columns, each column corresponding to one of the k sequences;

i) the primary column comprising the (symbol, position index) pairs of a primary sequence,

ii) the (k-1) suffix columns comprising (symbol, difference-in-position value) pairs, where the difference-in-position values are the position differences between all same symbols of each remaining sequence of the tuple and the primary sequence of the tuple,

iii) the rows in the k-tuple table resulting from forming all combinations of same symbols from each sequence;

d) creating a sorted k-tuple table by performing a multi-key sort on the k-tuple table, the sort keys being selected respectively from the difference-in-position values of the last suffix column (k^{th} column) through the difference-in-position value of the first suffix column; and

e) defining one or more patterns by collecting adjacent rows of the sorted k-tuple table whose suffix columns contain identical difference-in-position values, the relative positions of the symbols in each pattern being determined by the primary column position indices, the one or more patterns being common to the k sequences.

36. (Original) The method of claim 35 further comprising:

f) deleting all patterns not satisfying a predetermined criteria.

37. (Original) The method of claim 35 further comprising:

f) deleting all patterns shorter than a first predetermined span and longer than a second predetermined span.

38. (Original) The method of claim 35 further comprising:

f) deleting all patterns having fewer than a predetermined number of symbols.

39. (Original) The method of claim 35, further comprising the step of deleting rows from the k-tuple table which do not have suffix indices identical to any other row of the k-tuple table.

40. (Original) The method of claim 35 further comprising the step of deleting rows from the k-tuple table according to predetermined criteria.

41. (Previously presented) The method of claim 40, wherein rows sharing identical suffix column difference-in-position values are deleted from the k-tuple table if there are fewer than N_s such rows, where N_s is the minimum number of symbols per pattern.

42. (Previously presented) A method of discovering one or more patterns in a set of k+1 sequences of symbols, called a (k+1)-tuple, where k is greater than or equal to two, within an overall set of w sequences having sequence numbers 1, 2, ..., w , the symbols being members of an alphabet, each sequence of symbols having respective lengths L_1, L_2, ..., L_w by first forming a k-tuple table and then forming a (k+1)-tuple table by combining the k-tuple table with an additional sequence of symbols, the formation of the k-tuple table comprising the steps of:

a) translating the sequences of symbols into a table of ordered (symbol, position index) pairs, where the position index refers to the location of the symbol in a sequence;

b) for each of the w sequences, grouping the (symbol, position index) pairs by symbol to form a respective master offset table, thus creating w master offset tables;

c) using the position indices in the w master offset tables to determine the difference-in-position value between each occurrence of a symbol in one of the sequences and each occurrence of that same symbol in the other sequence in each master offset table , forming a k-tuple table associated with the k-tuple, the table comprising k columns, one of the k columns being a primary column and the remaining (k-1) columns being suffix columns, each column corresponding to one of the k sequences;

i) the primary column comprising the (symbol, position index) pairs of a primary sequence,

ii) the (k-1) suffix columns comprising (symbol, difference-in-position value) pairs, where the difference-in-position values are the position differences between all same symbols of each remaining sequence of the tuple and the primary sequence of the tuple,

iii) the rows in the k-tuple table resulting from forming all combinations of same symbols from each sequence;

d) creating a sorted k-tuple table by performing a multi-key sort on the k-tuple table, the sort keys being selected respectively from the difference-in-position values of the last suffix column (k^{th} column) through the difference-in-position value of the first suffix column;

the formation of the (k+1)-tuple table comprising the steps of:

e) translating the additional sequence of symbols into a table of ordered (symbol, position index) pairs, where the position index refers to the location of the symbol in the additional sequence of symbols;

f) grouping the (symbol, position index) pairs by symbol to form a master offset table;

g) creating the (k+1)-tuple table of k+1 columns, one of the k+1 columns being a primary column and the remaining k columns being suffix columns, by:

i) forming all combinations of same symbols between the primary column of the k-tuple table and the master offset table,

ii) for each such combination, duplicating the corresponding row of the k-tuple table, and appending a (symbol, difference-in-position value) pair corresponding to the difference between the position index of the master offset table and the position index of the primary column;

h) creating a sorted (k+1)-tuple table by performing a multi-key sort on the (k+1)-tuple table, the sort keys being selected respectively from the difference-in-position values of the last suffix column [$(k+1)^{th}$ column] through the difference-in-position value of the first suffix column; and

i) defining one or more patterns by collecting adjacent rows of the sorted (k+1)-tuple table whose suffix columns contain identical difference-in-position values, the relative positions of the symbols in each pattern being determined by the primary column position indices, the one or more patterns being common to the k+1 sequences.

43. (Previously presented) The method of claim 42 further comprising the step of:

deleting patterns from a k-tuple table common to the k-tuple table and a (k+1)-tuple table, where the (k+1)-tuple table contains all of the sequences of the k-tuple table with one additional sequence, by:

a) deleting the suffix column corresponding to a sequence not shared between the two tuple tables, thereby defining a modified table, and

b) deleting all rows from the k-tuple table whose suffix columns all contain identical sets of difference-in-position values to a row of the modified table.

44. (Previously presented) A method of discovering one or more patterns in a set of k sequences of symbols, called a k-tuple, comprising the steps of:

a) for a first pair of sequences of the k-tuple

i) translating each sequence of symbols into a table of ordered (symbol, position index) pairs, where the position index of each (symbol, position index) pair refers to the location of the symbol in the sequence;

ii) for each of the paired sequences, grouping the (symbol, position index) pairs by symbol to respectively form a first master offset table and a second master offset table;

iii) forming a Pattern Map comprising an array having (L1 + L2 –1) rows by:

A) subtracting the position index of the first master offset table from the position index of the second master offset table for every combination of (symbol, position index) pair having same symbols, the difference-in-position value resulting from each subtraction defining a row index;

B) storing each (symbol, position index) pair from the first master offset table in a row of the Pattern Map, the row being defined by the row index, until all (symbol, position index) pairs have been stored in the Pattern Map;

iv) defining a parent pattern by collecting symbols having the identical difference-in-position value from each row of the Pattern Map and populating an output array with the collected symbols, the symbols being placed at relative locations in the parent pattern indicated by the position index of the (symbol, position index) pair; and

v) repeating step iv) for each row of the Pattern Map;

b) storing the discovered patterns as arrays of (symbol, position index) pairs;

c) for each subsequent pair of sequences of the k-tuple, replacing the (symbol, position index) pairs of the first sequence of the pair of sequences by the (symbol, position index) pairs of the stored patterns; and

d) repeating steps (a) through (c) for each subsequent pair of sequences until the k-th sequence of the k-tuple is reached.

45. (Previously presented) The method of claim 35, further comprising the step of finding all patterns at all levels of support within a set of sequences by:

f) forming a tree of nodes, where each node corresponds to each combination of k sequences, and therefore represents a k-tuple, and wherein each node representing a k-tuple is connected to all nodes representing (k+1)-tuples, each (k+1)-tuple being formed by adding a unique sequence to the k-tuple, where the sequence being added is later in the ordered list of sequences than the latest sequence of the k-tuple;

g) traversing the tree, and at each node visited during traversal, defining one or more patterns by collecting adjacent rows of the sorted k-tuple table whose suffix columns contain identical sets of difference-in-position values, the relative positions of the symbols in each pattern being determined by the primary column position indices, the one or more patterns being common to the k sequences.

46. (Original) The method of claim 45, wherein the traversal of the tree of nodes is accomplished via recursion.

47. (Previously presented) The method of claim 45, further comprising the step of:

h) removing duplicate patterns at each level of support.

48. (Previously presented) The method of claim 47, wherein the removal of duplicate patterns at each level of support step h) is accomplished by:

i) for each node corresponding to a (k+1)-tuple, identifying the nodes containing k-tuples whose sequences are subsets of the (k+1)-tuple; thereby defining a set of causally-dependent nodes;

ii) locating said causally-dependent nodes;

iii) removing from each said causally-dependent node the patterns in common with the (k+1)-tuple; and

iv) if the k-tuple table in a causally-dependent node is thereby reduced to zero length, removing the corresponding node and all of its descendents from the tree prior to their traversal.

49. (Previously presented) The method of claim 48, wherein locating causally-dependent nodes in step ii) comprises the steps of:

(A) organizing the nodes at level k in the Tuple-tree into a linked list which is ordered from left to right in accordance with the sequence numbers represented by each tuple; and

(B) searching said linked list for nodes which are causally-dependent on a particular (k+1)-tuple.

50. (Original) The method of claim 48, wherein the nodes located in step ii) are causally-dependent nodes at level k determined with respect to another node at level k, and are thus causally-dependent on a child of the another node at level k.

51. (Previously presented) The method of claim 47, wherein the removal of duplicate patterns at each level of support step h) comprises the steps of:

i) organizing the nodes at level k in the Tuple-tree into a linked list which is ordered from left to right in accordance with the sequence numbers of each tuple;

ii) for each pattern in the current node at level k, storing a "hit list" array of the sequence numbers of the sequences containing the pattern;

iii) for all nodes to the right of the current node whose sequence numbers are all in the hit list, searching for a duplicate instance of the pattern, and if found, eliminating it; and

iv) making each node the current node, repeating steps (ii) and (iii), in the order of the node's appearance in the linked list.

52. (Previously presented) The method of claim 51, wherein, in step iii), the nodes consistent with the hit list are found using a hash tree, the hash tree having a root and k levels of nodes, the k-th level of the hash tree having a plurality of leaf nodes, the respective level of nodes of the hash tree corresponding to the respective sequence numbers of a k-tuple, the leaf nodes identifying the k-tuple whose sequence numbers correspond to the path from the root to the leaf node, wherein

searching the nodes for pattern duplicates is performed by repeating steps ii) and iii) for each node in the order of the appearance of that node in the hash tree.

53. (Previously presented) The method of claim 45 wherein the traversing step c) itself comprises the steps of:

i) creating a Virtual Sequence Array of patterns found within the sequences, wherein the patterns are termed P-nodes and the tuple nodes are termed T-nodes,

(ii) finding a P-node list corresponding to the location of each pattern in the primary sequence of that tree node,

iii) searching the P-node list for a duplicate instance of the pattern,

(A) if no duplicate is found:

(1) adding a pointer to the pattern of the current T-node pattern array,

(2) finding all locations of the pattern within the Virtual Sequence Array,

(3) adding a pointer to the pattern to each corresponding P-node array;

(B) if a duplicate pattern is found:

(1) ignoring the pattern if the duplicate pattern was found at support equal to the current level of support,

(2) if the duplicate pattern was found at a previous level of support, unlinking the duplicate pattern from its previous T-node (if it exists), and relinking the duplicate pattern to the current T-node,

(3) repeating steps 1) and 2) until all of the children of a T-node have been created, thus insuring that patterns of that T-node that are at their ultimate level of support are reported, and

(4) deleting the T-node.

Claims 54-65 Cancelled

66. (Previously presented) A computer-readable medium containing a plurality of data structures useful in controlling a computer system to discover one or more patterns in k sequences of symbols within an overall set of w sequences, the plurality of data structures comprising:

a number w of master offset table data structures each grouping,

for each value of a difference in position between each occurrence of a symbol in one of the sequences and each occurrence of that same symbol in each other sequence,

the position (position index) in the first sequence of each symbol therein that appears in each of the other sequences at that difference-in-position value;

a k-tuple table data structure comprising columns and rows, the columns comprising (symbol, position index) pairs and (symbol, difference-in-position value) pairs; and

a sorted k-tuple table data structure comprising a row-sorted representation of the (symbol, position index) pairs and (symbol, difference-in-position value) pairs contained in the k-tuple table data structure,

wherein adjacent rows of the sorted k-tuple table data structure whose suffix columns contain identical difference-in-position values define one or more patterns of symbols, the relative positions of symbols in each pattern being determined by the primary column position indices in the sorted k-tuple table data structure.

67. (Previously presented) The computer-readable medium of claim 66 wherein the sorted k-tuple table data structure further groups, for each value of a difference in position, the number of symbols in the first sequence that appear in the second sequence at that difference-in-position value.

68. (Previously presented) A computer-readable medium containing instructions for controlling a computer system to discover one or more patterns in

a set of k sequences of symbols, called a k-tuple, where k is greater than or equal to two, within an overall set of w sequences having sequence numbers 1, 2, ..., w , the symbols being members of an alphabet, each sequence of symbols having respective lengths L_1, L_2, ..., L_w, by executing a method comprising the steps of:

a) translating the sequences of symbols into a table of ordered (symbol, position index) pairs, where the position index refers to the location of the symbol in a sequence;

b) for each of the w sequences, grouping the (symbol, position index) pairs by symbol to form a respective master offset table, thus creating w master offset tables;

c) using the position indices in the w master offset tables to determine the difference-in-position value between each occurrence of a symbol in one of the sequences and each occurrence of that same symbol in the other sequence in each master offset table, forming a k-tuple table associated with the k-tuple, the table comprising k columns, one of the k columns being a primary column and the remaining (k-1) columns being suffix columns, each column corresponding to one of the k sequences;

i) the primary column comprising the (symbol, position index) pairs of a primary sequence,

ii) the (k-1) suffix columns comprising (symbol, difference-in-position value) pairs, where the difference-in-position values are the position differences between all same symbols of each remaining sequence of the tuple and the primary sequence of the tuple,

iii) the rows in the k-tuple table resulting from forming all combinations of same symbols from each sequence;

d) creating a sorted k-tuple table by performing a multi-key sort on the k-tuple table, the sort keys being selected respectively from the difference-in-position values of the last suffix column (k^{th} column) through the difference-in-position value of the first suffix column; and

e) defining a one or more patterns by collecting adjacent rows of the sorted k-tuple table whose suffix columns contain identical difference-in-position values, the relative positions of the symbols in each pattern being determined by the primary column position indices, the one or more patterns being common to the k sequences.

EVIDENCE APPENDIX

None

RELATED PROCEEDINGS APPENDIX

None

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[1]de·fense *or* **de·fence** \di-'fen(t)s; *as antonym of "offense," often* 'dē-ˌ\ *n* [ME, fr. OF, fr. (assumed) VL *defensa*, fr. L, fem. of *defensus*, pp. of *defendere*] **1 a** : the act or action of defending <the ~ of one's country> <to speak out in ~ of justice> **b** : a defendant's denial, answer, or plea **2** : capability of resisting attack **3 a** : means or method of defending or protecting oneself or another; *also* : a defensive structure **b** : an argument in support or justification **c** : the collected facts and method adopted by a defendant to protect himself against a plaintiff's action **d** : a sequence of moves available in chess to the second player in the opening **4 a** : a defending party or group (as in a court of law) <the ~ rested its case> **b** : a defensive team **5** : the military, governmental, and industrial aggregate esp. in its capacity of authorizing and supervising arms production <~ budget> < ~ contract> — **de·fense·less** \-ləs\ *adj* — **de·fense·less·ly** *adv* — **de·fense·less·ness** *n*

[2]defense *vt* **de·fensed; de·fens·ing** : to take specific defensive action against (an opposing team or player)

de·fense·man \-mən, -ˌman\ *n* : a player in a sport (as hockey) assigned to a defensive zone or position

defense mechanism *n* **1** : a defensive reaction by an organism **2** : an often unconscious mental process (as repression, projection, or sublimation) that enables the ego to reach compromise solutions to problems

de·fen·si·ble \di-'fen(t)-sə-bəl\ *adj* : capable of being defended — **de·fen·si·bil·i·ty** \di-ˌfen(t)-sə-'bil-ət-ē, ˌdē-\ *n* — **de·fen·si·bly** \-blē\ *adv*

[1]de·fen·sive \di-'fen(t)-siv, 'dē-ˌ\ *adj* **1** : serving to defend or protect **2 a** : devoted to resisting or preventing aggression or attack **b** : of or relating to the attempt to keep an opponent from scoring in a game or contest **3 a** : valuable in defensive play <a ~ card in bridge> **b** : designed to keep an opponent from being the highest bidder <a ~ bid> — **de·fen·sive·ly** *adv* — **de·fen·sive·ness** *n*

[2]defensive *n* : a defensive position — **on the defensive** : in the state or condition of being prepared for an expected aggression or attack

[1]de·fer \di-'fər\ *vt* **de·ferred; de·fer·ring** [ME *deferren, differren*, fr. MF *differer*, fr. L *differre* to postpone, be different — more at DIFFER] : to put off : DELAY <forced to ~ college because of financial problems> — **de·fer·rer** *n*

syn DEFER, POSTPONE, INTERMIT, SUSPEND, STAY *shared meaning element* : to delay an action or proceeding

[2]defer *vb* **deferred; deferring** [ME *deferren, differren*, fr. MF *deferer, defferer*, fr. LL *deferre*, fr. L, to bring down, bring, fr. *de-* + *ferre* to carry — more at BEAR] *vt* : to delegate to another <he could ~ his job to no one —J. A. Michener> ~ *vi* : to submit to another's wishes, opinion, or governance usu. through deference or respect <a man who *deferred* only to God> *syn* see YIELD

def·er·ence \'def-(ə-)rən(t)s\ *n* : respect and esteem due a superior or an elder; *also* : affected or ingratiating regard for another's wishes *syn* see HONOR *ant* disrespect — **in deference to** : in consideration of

[1]def·er·ent \'def-ə-rənt, -ər-ənt\ *adj* [L *deferent-, deferens*, prp. of *deferre*] : serving to carry down or out <a ~ conduit>

[2]def·er·ent \'def-(ə-)rənt\ *adj* [back-formation fr. *deference*] : DEFERENTIAL

def·er·en·tial \ˌdef-ə-'ren-chəl\ *adj* : showing or expressing deference <~ attention> — **def·er·en·tial·ly** \-'rench, -rench-(ə-)lē\ *adv*

de·fer·ment \di-'fər-mənt\ *n* : the act of delaying or postponing; *specif* : official postponement of military service

de·fer·ra·ble \di-'fər-ə-bəl\ *adj* : capable of or suitable or eligible for being deferred — **deferrable** *n*

de·fer·ral \di-'fər-əl\ *n* : DEFERMENT

de·ferred *adj* **1** : withheld for or until a stated time <a ~ payment> **2** : charged in cases of delayed handling <a ~ rate>

de·fer·ves·cence \ˌdē-(ˌ)fər-'ves-ᵊn(t)s, ˌdef-ər-\ *n* [G *deferveszenz*, fr. L *defervescent-, defervescens*, prp. of *defervescere* to stop boiling, fr. *de-* + *fervescere* to begin to boil — more at EFFERVESCE] : the subsidence of a fever

de·fi·ance \di-'fī-ən(t)s\ *n* **1** : the act or an instance of defying : CHALLENGE **2** : disposition to resist or contempt of opposition — **in defiance of** : contrary to : DESPITE <worked *in defiance of* doctor's orders>

de·fi·ant \-ənt\ *adj* [F *défiant*, fr. OF, prp. of *defier* to defy] : full of defiance : BOLD — **de·fi·ant·ly** *adv*

de·fi·bril·late \(ˌ)dē-'fib-rə-ˌlāt, -'fīb-\ *vt* : to restore the rhythm of (a fibrillating heart) — **de·fi·bril·la·tion** \(ˌ)dē-ˌfib-rə-'lā-shən, -ˌfīb-\ *n* — **de·fi·bril·la·tive** \(ˌ)dē-'fib-rə-ˌlāt-iv, -'fīb-\ *adj* — **de·fi·bril·la·tor** \-ˌlāt-ər\ *n* — **de·fi·bril·la·to·ry** \(ˌ)dē-'fib-rə-lə-ˌtōr-ē, -'fīb-; ˌdē-fī-'bril-ə-\ *adj*

de·fi·brin·ate \(ˌ)dē-'fib-rə-ˌnāt, -'fīb-\ *vt* **-at·ed; -at·ing** : to remove fibrin from (blood) — **de·fi·brin·ation** \(ˌ)dē-ˌfib-rə-'nā-shən, -ˌfīb-\ *n*

de·fi·cien·cy \di-'fish-ən-sē\ *n, pl* **-cies** **1** : the quality or state of being deficient : INADEQUACY **2 a** : a shortage of substances necessary to health **b** : absence of one or more genes from a chromosome

deficiency disease *n* : a disease (as scurvy) caused by a lack of essential dietary elements and esp. a vitamin or mineral

[1]de·fi·cient \di-'fish-ənt\ *adj* [L *deficient-, deficiens*, prp. of *deficere* to be wanting — more at DEFECT] **1** : lacking in some necessary quality or element <~ in judgment> **2** : not up to a normal standard or complement : DEFECTIVE <~ strength> — **de·fi·cient·ly** *adv*

[2]deficient *n* : one that is deficient <a mental ~>

def·i·cit \'def-ə-sət *also, esp Brit,* di-'fis-ət *or* 'dē-fə-sət\ *n* [F *déficit*, fr. L *deficit* it is wanting, 3d sing. pres. indic. of *deficere*] **1 a** : deficiency in amount or quality <a ~ in rainfall> **b** : DISADVANTAGE <a two-run homer in the sixth that overcame a 2-1 ~> **2 a** : an excess of expenditure over revenue **b** : a loss in business operations

deficit spending *n* : the spending of public funds raised by borrowing rather than by taxation

de·fi·er \di-'fī(-ə)r\ *n* : one that defies

[1]def·i·lade \'def-ə-ˌlād, -ˌlād\ *vt* **-lad·ed; -lad·ing** [prob. fr. *de-* + *-filade* (as in *enfilade*)] : to arrange (fortifications) so as to protect the lines from frontal or enfilading fire and the interior of the works from plunging or reverse fire

[2]defilade *n* : the act or process of defilading

[1]de·file \di-'fī(ə)l\ *vt* **de·filed; de·fil·ing** [ME *defilen*, alter. of *defoulen* to trample, defile, fr. OF *defouler* to trample, fr. *de-* + *fouler* to trample, lit., to full — more at FULL] : to make unclean or impure : BEFOUL, BESMIRCH: as **a** : to corrupt the purity or perfection of : DEBASE <the countryside *defiled* by billboards> **b** : to denude of chastity : DEFLOWER **c** : to make physically unclean esp. with something unpleasant or contaminating <boots *defiled* with blood> **d** : to make ceremonially unclean <~ a sanctuary> **e** : SULLY, DISHONOR *syn* see CONTAMINATE — **de·file·ment** \-'fī(ə)l-mənt\ *n* — **de·fil·er** \-'fī-lər\ *n*

[2]de·file \di-'fī(ə)l, 'dē-ˌfīl\ *vi* **de·filed; de·fil·ing** [F *défiler*, fr. *dé-* de- + *filer* to move in a column — more at FILE] : to march off in a line

[3]de·file \di-'fī(ə)l, 'dē-ˌfīl\ *n* [F *défilé*, fr. pp. of *défiler*] : a narrow passage or gorge

de·fin·able \di-'fī-nə-bəl\ *adj* : capable of being defined, limited, or explained — **de·fin·ably** \-blē\ *adv*

de·fine \di-'fīn\ *vb* **de·fined; de·fin·ing** [ME *definen*, fr. MF & L; MF *definer*, fr. L *definire*, fr. *de-* + *finire* to limit, end, fr. *finis* boundary, end — more at FINAL] *vt* **1 a** : to fix or mark the limits of : DEMARCATE <rigidly *defined* property lines> **b** : to make distinct, clear, or detailed in outline <the issues aren't too well *defined*> **2 a** : to determine or identify the essential qualities or meaning of <~ a powerful position by salary and prestige> <whatever ~*s* us as human> **b** : to discover and set forth the meaning of (as a word) **3** : CHARACTERIZE, DISTINGUISH <good manners ~ the gentleman> ~ *vi* : to make a definition — **de·fine·ment** \-'fīn-mənt\ *n* — **de·fin·er** \-'fī-nər\ *n*

de·fin·i·en·dum \di-ˌfin-ē-'en-dəm\ *n, pl* **-da** \-də\ [L, something to be defined, neut. of *definiendus*, gerundive of *definire*] : an expression that is being defined

de·fin·i·ens \di-'fin-ē-ˌenz\ *n, pl* **de·fin·i·en·tia** \di-ˌfin-ē-'en-ch(ē-)ə\ [L, prp. of *definire*] : an expression that defines : DEFINITION

def·i·nite \'def-(ə-)nət\ *adj* [L *definitus*, pp. of *definire*] **1** : having distinct or certain limits <set ~ standards for pupils to meet> **2 a** : free of all ambiguity, uncertainty, or obscurity <demanded a ~ answer> **b** : UNQUESTIONABLE, DECIDED <the quarterback was a ~ hero today> **3** : typically designating an identified or immediately identifiable person or thing <the ~ article *the*> **4 a** : being constant in number, usu. less than 20, and occurring in multiples of the petal number <stamens ~> **b** : CYMOSE *syn* see EXPLICIT *ant* indefinite, equivocal — **def·i·nite·ly** *adv* — **def·i·nite·ness** *n*

definite integral *n* : a number that is the difference between the values of the indefinite integral of a given function for two values of the independent variable

def·i·ni·tion \ˌdef-ə-'nish-ən\ *n* **1** : an act of determining; *specif* : the formal proclamation of a Roman Catholic dogma **2** : a word or phrase expressing the essential nature of a person or thing : MEANING <the confinement of God within our human ~> **3 a** : a statement of the meaning of a word or word group or a sign or symbol <dictionary ~*s*> **b** : the action or process of stating such a meaning **4 a** : the action or the power of describing, explaining, or making definite and clear <the ~ of a telescope> <her comic genius is beyond ~> **b** (1) : distinctness of outline or detail (as in a photograph) (2) : clarity esp. of musical sound in reproduction **c** : sharp demarcation of outlines or limits <a jacket with definite waist ~> — **def·i·ni·tion·al** \-'nish-nəl, -'nish-ən-ᵊl\ *adj*

[1]de·fin·i·tive \di-'fin-ət-iv\ *adj* **1** : serving to provide a final solution <a ~ victory> **2** : authoritative and apparently exhaustive <a ~ biography> **3** : serving to define or specify precisely <~ laws> **4** : fully differentiated or developed **5** *of a postage stamp* : issued as a regular stamp for the country or territory in which it is to be used *syn* see CONCLUSIVE *ant* tentative, provisional — **de·fin·i·tive·ly** *adv* — **de·fin·i·tive·ness** *n*

[2]definitive *n* : a definitive postage stamp — compare PROVISIONAL

definitive host *n* : the host in which the sexual reproduction of a parasite takes place

de·fi·ni·tize \'def-(ə-)nə-ˌtīz, di-'fin-ə-\ *vt* **-tized; -tiz·ing** : to make definite

de·fi·ni·tude \di-'fin-ə-ˌt(y)üd, -'fī-nə-\ *n* [irreg. fr. *definite*] : PRECISION, DEFINITENESS

def·la·grate \'def-lə-ˌgrāt\ *vb* **-grat·ed; -grat·ing** [L *deflagratus*, pp. of *deflagrare* to burn down, fr. *de-* + *flagrare* to burn — more at BLACK] *vi* : to burn rapidly with intense heat and sparks being given off ~ *vt* : to cause to deflagrate — compare DETONATE — **def·la·gra·tion** \ˌdef-lə-'grā-shən\ *n*

de·flate \di-'flāt, 'dē-\ *vb* **de·flat·ed; de·flat·ing** [*de-* + *-flate* (as in *inflate*)] *vt* **1** : to release air or gas from **2** : to reduce in size or importance <~ his ego with cutting remarks> **3** : to reduce (a price level) or cause (a volume of credit) to contract ~ *vi* : to lose firmness through or as if through the escape of contained gas *syn* see CONTRACT *ant* inflate — **de·fla·tor** \-'flāt-ər\ *n*

de·fla·tion \di-'flā-shən, 'dē-\ *n* **1** : an act or instance of deflating : the state of being deflated **2** : a contraction in the volume of available money or credit that results in a decline of the general price level **3** : the erosion of soil by the wind — **de·fla·tion·ary** \-shə-ˌner-ē\ *adj*